

IN THE CLAIMS

1. (Cancelled)

2. (Cancelled)

3. Withdrawn

4. (Cancelled)

5. Withdrawn

6. (Cancelled)

7. (Cancelled)

8. (Cancelled)

9. Withdrawn

10. (New) A method for filling a mold by a fill profile having at least four filling stages, stage 1, stage 2, stage 3 and stage 4, associated with four time intervals,  $t_0$  to  $t_1$ ,  $t_1$  to  $t_2$ ,  $t_2$  to  $t_3$ , and  $t_3$  to  $t_4$ , respectfully, and with four pressure change intervals,  $P_0$  to  $P_1$ ,  $P_1$  to  $P_2$ ,  $P_2$  to  $P_3$  and  $P_3$  to  $P_4$ , respectively, to make a cast article comprising the steps of:

- (a) providing a molten metal to a casting chamber in fluid communication with the mold, the casting chamber having a supply conduit for introducing a gas into the casting chamber, and the casting chamber having an evacuation conduit for delivering the molten metal from the casting chamber to the mold;
- (b) controlling the filling of the mold during the first time interval  $t_0$  to  $t_1$  of stage 1 by delivering the molten metal from the casting chamber to the mold at a first rate by supplying the gas to the casting chamber during stage 1 at  $t_0$  at  $P_0$  and at  $t_1$  at  $P_1$  to allow the molten metal to rise at the first rate, stage 1 including an acceleration portion wherein the molten metal is accelerated up to a desired fill rate for stage 1, the first rate operative to produce a first stage actual fill profile;
- (c) controlling the filling of the mold during the second time interval  $t_1$  to  $t_2$  of stage 2 by delivering the molten metal from the casting chamber to the mold at a second rate by supplying the gas to the casting chamber during stage 2 at  $t_1$  at  $P_1$  and at  $t_2$  at  $P_2$  to allow the molten metal to rise at the second rate, the second rate being less than the first rate whereby the mold fills more slowly with molten metal during stage 2 than during stage 1 to thereby produce a smooth transition in the filling of the mold cavity at the transition from the end of stage 1 to the beginning of stage 2, the second rate operative to produce a second stage actual fill profile;
- (d) controlling the filling of the mold during the third time interval  $t_2$  to  $t_3$  of stage 3 by delivering the molten metal from the casting chamber to the mold at a third rate by supplying the gas to the casting chamber during stage 3 at  $t_2$  at  $P_2$  and at  $t_3$  at  $P_3$  to allow the molten metal to rise at the third rate, the third rate being greater than the second rate whereby the mold fills more quickly with molten metal during stage 3 than during stage 2, the third rate operative to produce a third stage actual fill profile; and
- (e) controlling the filling of the mold during the fourth time interval  $t_3$  to  $t_4$  of stage 4 by delivering the molten metal from the casting chamber to the mold at a

fourth rate by supplying the gas to the casting chamber during stage 4 at  $t_3$  at  $P_3$  and at  $t_4$  at  $P_4$  to allow the molten metal to rise at the fourth rate, the fourth rate being less than the third rate whereby the mold fills more slowly with molten metal during stage 4 than during stage 3 to thereby produce a smooth transition in the filling of the mold cavity at the transition from the end of stage 3 to the beginning of stage 4, the fourth rate operative to produce a fourth stage actual fill profile.

11. (New) The method of Claim 1 further comprising the step of providing a controller for controlling filling of the mold during the at least four filling stages.

12. (New) A method for filling a mold by a fill profile having at least four filling stages, stage 1, stage 2, stage 3 and stage 4, associated with four time intervals,  $t_0$  to  $t_1$ ,  $t_1$  to  $t_2$ ,  $t_2$  to  $t_3$ , and  $t_3$  to  $t_4$ , respectfully, and with four pressure change intervals,  $P_0$  to  $P_1$ ,  $P_1$  to  $P_2$ ,  $P_2$  to  $P_3$  and  $P_3$  to  $P_4$ , respectively, to make a cast article comprising the steps of:

- (a) providing a molten metal to a casting chamber in fluid communication with the mold, the casting chamber having a supply conduit for introducing a gas into the casting chamber, and the casting chamber having an evacuation conduit for delivering the molten metal from the casting chamber to the mold;
- (b) providing a transducer and a controller;
- (c) controlling the filling of the mold during the first time interval  $t_0$  to  $t_1$  of stage 1 by delivering the molten metal from the casting chamber to the mold at a first rate by supplying the gas to the casting chamber during stage 1 at  $t_0$  at  $P_0$  and at  $t_1$  at  $P_1$  to allow the molten metal to rise at the first rate, stage 1 including an acceleration portion wherein the molten metal is accelerated up to a desired fill rate for stage 1, the first rate operative to produce a first stage actual fill profile;
- (d) controlling the filling of the mold during the second time interval  $t_1$  to  $t_2$  of stage 2 by delivering the molten metal from the casting chamber to the mold at a second rate by supplying the gas to the casting chamber during stage 2 at  $t_1$  at  $P_1$  and at  $t_2$  at  $P_2$  to allow the molten metal to rise at the second rate, the second rate being less than the first rate whereby the mold fills more slowly with molten metal during stage 2 than during stage 1 to thereby produce a smooth transition in the filling of the mold cavity at the transition from the end of stage 1 to the beginning of stage 2, the second rate operative to produce a second stage actual fill profile;
- (e) controlling the filling of the mold during the third time interval  $t_2$  to  $t_3$  of stage 3 by delivering the molten metal from the casting chamber to the mold at a third rate by supplying the gas to the casting chamber during stage 3 at  $t_2$  at  $P_2$  and at  $t_3$  at  $P_3$  to allow the molten metal to rise at the third rate, the third rate being greater than the second rate whereby the mold fills more quickly with molten metal during stage 3 than during stage 2, the third rate operative to produce a third stage actual fill profile; and
- (f) controlling the filling of the mold during the fourth time interval  $t_3$  to  $t_4$

of stage 4 by delivering the molten metal from the casting chamber to the mold at a fourth rate by supplying the gas to the casting chamber during stage 4 at  $t_3$  at  $P_3$  and at  $t_4$  at  $P_4$  to allow the molten metal to rise at the fourth rate, the fourth rate being less than the third rate whereby the mold fills more slowly with molten metal during stage 4 than during stage 3 to thereby produce a smooth transition in the filling of the mold cavity at the transition from the end of stage 3 to the beginning of stage 4, the fourth rate operative to produce a fourth stage actual fill profile;

wherein the transducer sends signals representative of the pressures in the casting chamber to the controller and the controller changes the filling of the mold from the first rate to the second rate to the third rate and to the fourth rate.

13. (New) A method for filling a mold by a fill profile having at least four filling stages, stage 1, stage 2, stage 3 and stage 4, associated with four time intervals,  $t_0$  to  $t_1$ ,  $t_1$  to  $t_2$ ,  $t_2$  to  $t_3$ , and  $t_3$  to  $t_4$ , respectfully, and with four pressure change intervals,  $P_0$  to  $P_1$ ,  $P_1$  to  $P_2$ ,  $P_2$  to  $P_3$  and  $P_3$  to  $P_4$ , respectively, to make a cast article comprising the steps of:

- (a) providing a molten metal to a casting chamber, the casting chamber having a supply conduit for introducing a gas into the casting chamber, and the casting chamber having an evacuation conduit for delivering the molten metal from the casting chamber to the mold;
- (b) providing a desired fill profile for delivering the molten metal from the casting chamber to the mold;
- (c) detecting the pressure in the casting chamber;
- (d) providing a controller and sending a signal representative of the pressure in the casting chamber to the controller; and
- (e) changing the desired fill profile based upon the signal representative of the pressure in the casting chamber;

wherein the desired fill profile includes at least controlling the filling of the mold during the first time interval  $t_0$  to  $t_1$  of stage 1 by delivering the molten metal from the casting chamber to the mold at a first rate by supplying the gas to the casting chamber during stage 1 at  $t_0$  at  $P_0$  and at  $t_1$  at  $P_1$  to allow the molten metal to rise at the first rate, stage 1 including an acceleration portion wherein the molten metal is accelerated up to a desired fill rate for stage 1, the first rate operative to produce a first stage actual fill profile, controlling the filling of the mold during the second time interval  $t_1$  to  $t_2$  of stage 2 by delivering the molten metal from the casting chamber to the mold at a second rate by supplying the gas to the casting chamber during stage 2 at  $t_1$  at  $P_1$  and at  $t_2$  at  $P_2$  to allow the molten metal to rise at the second rate, the second rate being less than the first rate whereby the mold fills more slowly with molten metal during stage 2 than during stage 1 to thereby produce a smooth transition in the filling of the mold cavity at the transition from the end of stage 1 to the beginning of stage 2, the second rate operative to produce a second stage actual fill profile; controlling the filling of the mold during the third time interval  $t_2$  to  $t_3$  of stage 3 by delivering the

molten metal from the casting chamber to the mold at a third rate by supplying the gas to the casting chamber during stage 3 at  $t_2$  at  $P_2$  and at  $t_3$  at  $P_3$  to allow the molten metal to rise at the third rate, the third rate being greater than the second rate whereby the mold fills more quickly with molten metal during stage 3 than during stage 2, the third rate operative to produce a third stage actual fill profile; and controlling the filling of the mold during the fourth time interval  $t_3$  to  $t_4$  of stage 4 by delivering the molten metal from the casting chamber to the mold at a fourth rate by supplying the gas to the casting chamber during stage 4 at  $t_3$  at  $P_3$  and at  $t_4$  at  $P_4$  to allow the molten metal to rise at the fourth rate, the fourth rate being less than the third rate whereby the mold fills more slowly with molten metal during stage 4 than during stage 3 to thereby produce a smooth transition in the filling of the mold cavity at the transition from the end of stage 3 to the beginning of stage 4, the fourth rate operative to produce a fourth stage actual fill profile.

14. (New) The method of Claim 6 further comprising the step of providing a transducer to detect the pressures in the casting chamber.